ANNALS OF SURGERY

THE TREATMENT OF TUBERCULOSIS OF BONES AND JOINTS BY PARENCHYMATOUS AND INTRA-ARTICULAR INJECTIONS.

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THE successful treatment in some cases of bone and joint tuberculosis by parenchymatous and intra-articular injections is one of the important achievements of modern surgery. Attempts in this direction were made long before the bacillus of tuberculosis was discovered, and before the true pathology of tubercular inflammation was understood. It is, however, since the true nature of the tubercular process has been revealed, and since the anti-bacterial action of a number of antiseptic substances has been carefully studied experimentally and clinically, that this method of treatment has been placed upon a scientific basis and has yielded satisfactory results. It is reasonable to assume that if by a harmless procedure safe and efficient chemical substances can be brought in contact with the affected tissues within diseased bones and joints that exercise a direct curative effect, it would constitute a decided improvement over former methods of treatment by internal administration or external application of the same remedies. The remedies which have been used for this purpose possess potent antiseptic and stimulating properties, and have been employed with a view to destroy the microbic cause of the disease, and to aid and expedite the process of repair.

The first attempts at intra-articular medication were made with a Pravaz syringe, the solution being thrown into the joint without previous evacuation of its fluid contents. At the present time the joint is punctured with a larger instrument, and if it contains fluid this is evacuated before the injection is made. If the joint contains tubercular pus, the intra-articular injection is preceded by irrigation of the joint with a mild antiseptic solution. The best instrument for puncturing a joint is a small trocar, through the canula of which the joint can be emptied, irrigated and injected. The puncture is to be made under strictest antiseptic precautions, and in accordance with the rules laid down elsewhere. In tubercular empyæma of a joint, irrigation should never be neglected as a preliminary step to the intra-articular injection. The simplest method of irrigating a joint is to connect the canula with a rubber tube attached to an irrigator holding the antiseptic solution. A 2% solution of boracic acid or a one-third of 1% solution of salicylic acid in sterilized water should be used for this purpose. The connection between canula and rubber tube should only be made after the surgeon has been satisfied that neither of them contain atmospheric air. By elevating the irrigator the fluid enters the joint, and the infusion should be continued until the capsule is thoroughly distended, when the rubber tube is detached and the fluid evacuated through the canula by compressing the joint. This procedure is repeated until the fluid returns perfectly clear. The intra-articular injection is made with an ordinary one ounce glass syringe, to the nozzle of which a piece of aseptic rubber tubing is attached, which is fastened to the end of the canula with the same care as in making the irrigation. The quantity of fluid which is to be injected should never be large enough to cause painful distension. After the canula is withdrawn the puncture should be sealed with a pledget of aseptic cotton and collodium.

Among the many substances which have been used for parenchymatous and intra-articular medication, I will only make mention of such that have received the most attention, and which experience has shown to be of some value.

Tincture of iodine.—This preparation of iodine, pure or di-

luted, with a solution of potassic iodide, was one of the first substances employed for intra-articular medication. The late Prof. Brainard, of Chicago, made extensive use of it in the treatment of chronic hydrops of joints. Usually the injection was made through the canula of a trocar after the joint had been emptied of its contents. The violent local and general reaction which sometimes followed the injection was in the way of a more general adoption of this method of treating diseased joints. It has yielded satisfactory results in the treatment of catarrhal synovitis as the vaso motor irritation which the iodine produces upon the inner surface of the cavity of the joint and the vascular changes connected with it bring about speedy retrograde metamorphosis of the inflammatory product, and hasten the process of absorption. It is never safe, even in such cases, to allow the tincture to remain in the joint, as the desired therapeutic effect can be obtained by injecting through the canula of the trocar from two to four drachms of the tincture, and after bringing it in contact with the entire surface of the joint by flexion and extension, friction and compression of the joint allow it to escape.

In the treatment of tubercular joints this remedy has not only proved a failure, but has often been followed by aggravation of the local conditions, and should be stricken from the list of therapeutic resources in the treatment of these affections.

Carbolic Acid.—Soon after carbolic acid was introduced into surgical practice as an antiseptic agent, it was also employed in the treatment of chronic inflammation of joints as an intra-articular injection. Hueter[1] resorted to parenchymatous and intra-articular injections of a 2 to 3% solution of carbolic acid in the treatment of chronic inflammation of bones and joints, upon the supposition that the carbolic acid when brought in direct contact with the diseased tissues would destroy the microbic cause of the inflammation. The injections were made with a Pravaz syringe every other day. In a case of osteomy-

[1]Die Wirkungen der parenchymatosen Carboln injectionen bri Entzüdengen der Gelenke und Knochen. Deutsche Zeitschrift f. Chirurgie, Bd. IV., p. 526, B. V., p. 120

elitis granulosa hyperplastica, the favorable effect of the injections became apparent soon after the treatment was commenced. Twenty injections in the course of five weeks resulted in a permanent cure.

Hueter's treatment was quite generally adopted in Germany but the results, on the whole, were so unsatisfactory that it was soon abandoned. The results have not been more encouraging by puncture and irrigation of the joint with solutions of carbolic acid, and at the present time carbolic acid has been given up almost completely as an anti-tubercular remedy. The same fate has met the following two substances:

Arsenious Acid.—Cavagnis,[1] of Venice, made a number of experiments on rabbits and guinea pigs to determine the therapeutic value of arsenic in the treatment of tuberculosis.

On April 17, 1881, four rabbits, two gray and two black weighing respectively 1,580, 1,590, 1,660 and 1,680 grammes, and four guinea pigs, weighing 370, 500, 510 and 610 grammes, were inoculated with tubercular material by subcutaneous injection. From the date of inoculation until May 28, the gray rabbits received one drop of Fowler's solution, diluted with distilled water, daily; the medicine was injected into the back part of the mouth with a Pravaz syringe; the black rabbits were given two drops daily in the same manner, while the guinea pigs received only half a drop. The smallest guinea pig was killed May 21, all the other animals June 6. One of the rabbits and all guinea pigs were tubercular, a tubercular ulcer at the point of inoculation had developed, the tissues of which contained numerous bacilli; cheesy foci in the vicinity of the ulcer, lumbar and prehepatic glands enlarged and partly cheesy, spleen enlarged, containing numerous tubercles; liver also the seat of tuberculosis. One of the guinea pigs had nine small tubercles in the lungs.

The other three rabbits presented an encapsulated abscess at site of inoculation, and one or two small cheesy masses in the vicinity, but aside of this, no evidences of tuberculosis could be detected. Inoculations made with the contents of the abscesses yielded negative results.

[1] Études de la Tuberculose, p. 462.

Landerer used this substance dissolved in distilled water in the proportion of 1:1000, and of this he injected from one to two syringefuls at intervals of a few days into the affected joint. The results must have been decidedly unfavorable, as it does not appear that this remedy was used for the same purpose by others.

Corrosive Sublimate.—Next to carbolic acid corrosive sublimate has been used more extensively as an antiseptic in the treatment of wounds than any other substance, but has never been popular as an anti-tubercular remedy. Experiments made by Cavagnis[3] to test its anti bacillary action yielded very favorable results as far as its action is concerned in preventing the growth of tubercle bacilli in the tissues of the rabbits.

On April 17, 1887, he inoculated three rabbits and three guinea pigs with tubercular material, and subjected these animals at once to a thorough treatment with corrosive sublimate, which was administered in doses of four drops of a solution of one part in hundred of distilled water, while the guinea pigs receive only one-fourth of this quantity. May 1, one rabbit died; another May 10; the animals were very much emaciated, and the necropsy revealed a small mass of cheesy appearance at the point of injection; no bacilli could be found in the caseous material, and the internal organs showed no trace of tuberculosis. The third rabbit became so emaciated that treatment was suspended May 10, and ten days later the animal died. A large abscess containing non-tubercular pus was found where the injection was made. Internal organs and lymphatic glands healthy. The guinea pigs were killed June 7. These animals presented a tubercular ulcer at the site of injection, extensive tuberculosis of the lymphatic glands, spleen and liver.

Vogt injected from three to five syringefuls into tubercular joints of the following solution: Corrosive sublimate 0.1, sodic chloride 1.0, distilled water, 50.0, but evidently without success, as Vogt himself soon suspended its use.

Another remedy that seems to have been used only by the one who suggested it and a few others is

[3]Op. cit.

Phosphate of Lime.—Kolischer[4] used an acidulated solution of phosphate of lime for parenchymatous and intra-articular injections in tuberculosis of bones and joints. The injections were made with an ordinary Pravaz syringe. Pain and other symptoms of local reaction always followed the injection and continued for five to six days, after which the limb was immobilized. After this the swelling diminished in size, and the tissues became firmer, showing that healing by cicatrization was progressing in a satisfactory manner.

E. Freund[5] gives full directions for the preparation of the solution and gauze of acid phosphate of lime.

In another publication Kolischer[6] reports 500 cases treated by his method, and admits that while tubercular joint affections were benefited by the treatment, it had no such influence in cases of central foci in bone and the sequestrating form of bone tuberculosis. This treatment was faithfully tried in the Klinik at Tübingen, but with negative results as we learn from the paper published by E. Müller.[7] It is not probable that the use of this remedy will be revived in the future in the treatment of tubercular affections of bones and joints.

Chloride of Zinc.—Lannelongue made an important contribution to the Academy of Medicine of Paris concerning the local treatment of tuberculosis by injections of solutions of chloride of zinc. His attention was called to this remedy during the treatment of a case of lymph-angioma. He noticed that one of its effects was its power of changing softened tissues into hard fibrous structures. During the last few months he treated 20 cases of surgical tuberculosis by parenchymatous injections of a solution of chloride of zinc. The injection is made into the periphery of the tubercular lesions, so as to stimulate the surrounding healthy tissue to active proliferation,

[4]Ein neue Heilverfahren bei lokalisirten Tuberculösen Processen. Wiener Med. Presse B. XXVIII, No. 22, 1887.

[5]Ueber die bei Kalkbehandlung der Local tuberculose zur Verwendung gelangender Losungen. Wiener Med. Presse B. XXVIII, No. 24, 1887.

[6]Erahrungen über die Kalkbehandlung bei Local tuberkulose, Wiener Med. Presse, B. XXVII, No. 29.

[7]Ueber die Kalkbehandlung der localisirten tuberculösen Processe. Centralblatt f. Chirurgie, No. 15, 1888.

by which the focus is encapsulated. For tubercular disease of the knee four or five injections are usually made around the circumference of the superior cul-de-sac. From eight to ten drops of the solution (10%) suffice for the knee of a child, æt. 10. He claims excellent results in the treatment of tuberculosis of the lymphatic glands, and reports a few joint cases similarly benefited.

Balsam of Peru.—More than 30 years ago Sayre employed balsam of Peru in dressing wounds after resection of joints for tubercular affections. The results following his operations were much better than the average in the hands of other surgeons at that time, and we must attribute them, at least in part, to the use of this substance as a wound dressing.

Quite recently Landerer[8] has again called attention to the utility of the action of this antiseptic in arresting tubercular inflammation. As the result of his experiments on animals and from clinical experience with this remedy, he has come to the conclusion that its therapeutic action is owing to its stimulating effect on the tissues which brings the parts in such a condition as to render the pathogenic action of tubercle bacilli harmless. He ascertained by his experiments on rabbits that had been rendered tubercular by inoculation that the disease was favorably influenced by innocuous injections of an alkaline emulsion of this drug. In the treatment of fistulæ and deep-seated tubercular processes he uses a solution of the balsam in sulphuric ether 1-5 for injection.

For parenchymatous injections he employs an emulsion of the strength of 1:4 composed of oil of sweet almonds and a .07% solution of sodic chloride.

He reports 25 cases of tuberculosis of bone, generally implicating joints, greatly improved by injections of an emulsion of balsam of Peru combined in some cases with minor operative procedures, and in some of these cases the joint affections were so serious that amputation was proposed, but the operation was refused by the patients.

[8]Eine neue Behandlungsweise tuberculöser Processe. Münch Med. Wochenschrift, No. 40, 1888.

Vámossy[9] has made extensive use of gauze prepared with balsam of Peru in the treatment of open wounds after the removal of tubercular products with signal success. He reports 28 cases treated according to Landerer's method and expresses himself as satisfied with the results. Among these cases he observed albuminuria three times, cystitis twice, and acute nephritis once, affections of the genito-urinary organs which he believes were cured by the balsam.

Binz[10] also calls attention to the irritating effect of this drug on the urinary apparatus.

Landerer thinks the danger in the use of the balsam has been greatly overestimated, and that it can be avoided by proper care in its use.

Although balsam of Peru does not appear to possess any direct anti-bacillary properties there can be no doubt that it can be applied with great benefit in the treatment of tuberculosis of bones and joints, especially after fistulous openings and open ulcerating surfaces have formed, as well as a dressing after resection of joints and the treatment of tubercular abscesses by incision and curetting.

Camphorated Naphthol.—Camphorated naphthol was first prepared by Désesquelle in 1888, and was first used in the surgical service of Pércer, at the Hôpital Lariboisière. It is a liquid prepared by taking b. naphthol 100 grammes, camphor 200 grammes, pulverizing each substance finely, gently heating the mixture until complete fusion; filter and preserve the liquid obtained in yellow glass bottles well corked. It possesses valuable antiseptic properties and is strongly recommended by Reboul[11] in the treatment of tuberculosis of bones and joints. He believes that in the local treatment of these affections the employment of potent antiseptic remedies is indicated, and such substances should be selected which, of equal therapeutic value, are non-toxic, so that they can be

[9]Zur Therapie der Localtuberculose mit Perubalsam. Wiener Med. Presse, B. xxx, No. 17-20, 1889.

[10]Ueber den Perubalsam. Centralblatt f. klin. Medicin., B. x, 1889.

[11]Contribution a l' étude du Traitement de la tuberculose des os, des articulations et des Synoviatis tendineuses de l'emploi du Naphthol Camphré. Études experimentale et cliniques sur la Tuberculose, Paris, 1888-1890, p. 608.

used freely and for a long time. According to his estimation camphorated naphthol fills these two conditions, being only slightly toxic, an efficient antiseptic, and destructive to the tubercle bacillus. As naphthol camphor dissolves iodine, the following mixture can be used.

Naphthol camphor, - - - - -	90.0.
Iodine, - - - - - - -	10.0.

The antiseptic properties of camphor naphthol have been demonstrated experimentally by Maximowitch, Park, Burrel and Edington, and corroborated by the clinical results of Nicaisé, Fernet, Schwartz, Peyrot, Reboul and others. The successful treatment of local tubercular foci by camphor naphthol has been established by the results obtained; but the action of this drug seems to be general as well, since the naphthol is absorbed and has been found in the urine, in a free state, of persons dressed with camphorated naphthol (Désesquelle).

If a wound after operations for tubercular affections is dressed with camphorated naphthol the urine shows the presence of naphthol for eight days, showing that its local and general action is prolonged, and may prevent relapses, secondary inoculations, complications following so frequently operations for local tuberculosis.

Périer and Reboul have employed camphorated naphthol extensively as an injection in doses varying from 50 to 100 grammes in the treatment of articular tuberculosis and tubercular abscesses with favorable results. The injections did not produce pain and were never followed by violent local reaction or symptoms of intoxication.

Parenchymatous injections made with an ordinary Pravaz syringe proved equally successful in the different forms of local tuberculosis. The injections were repeated every eight days.

Reboul reports a large number of cases of tuberculosis of bones and joints treated by incision, scraping and injections and dressings of naphthol camphor in which the results were all that could be desired, speedy healing of the wound and freedom of relapse. In a number of cases of spina ventosa, puncture and parenchymatous injections of camphor naphthol re-

peated weekly resulted in a permanent cure within three months. He believes that the curative effect of camphor naphthol like other anti-tubercular remedies, when applied locally, consists mainly in the production of an irritative ostitis, and supports this opinion by citing the case of a patient treated for a tubercular lesion of the great trochanter with camphorated naphthol, who died of pulmonary tuberculosis. Around the tubercular focus which had been treated the bone presented the characteristic appearances of plastic osteomyelitis, and no bacilli or miliary tubercles could be found. The action of the remedy substitutes for the tubercular a plastic osteomyelitis.

Reboul has great faith in the conscientious use of camphor naphthol as a local application and dressing in resection of tubercular joints in securing an aseptic healing of the wound and guarding against local relapses and general miliary tuberculosis. He cites a number of operations of this kind on the larger joints in which this remedy was relied upon exclusively as an antiseptic, and the results certainly appear to corroborate the claims made for it.

He has also been satisfied with the results of interstitial injections with camphor naphthol in the treatment of fungous disease of joints.

Iodoform.—Injections of iodoform in the treatment of tuberculosis of bones and joints and tubercular abscesses were advised by Billroth and Mikulicz[12] ten years ago, and the latter published another paper on this subject a year later,[13] but it was not until a few years later that it came into more general use through the teachings and writings of Mosetig v. Moorhof.[14]

Mazzoni[15] believes that iodol. ether glycerin injections into the tissues or joints has a favorable effect on tubercular lesions not only in arresting the disease, but also in expediting the subsequent reparative process.

[12]Berliner klin. Wochenschrift, 1881.

[13]Die Verwendung des Iodoforms in der Chirurgie. Archiv. f. klinische Chirurgie, B. xvii, p. 3, 1882).

[14]Zur Iodoformfrage. Wiener Medicinische Blätter, B. viii, No. 10-12, 1885.

[15]Ueber die Amvendung des Iodols in der chirurgischen Praxis. Berl. klin. Wochenschrift, No. 41. 1886.

At the present time the anti-tubercular action of iodoform is generally recognized from a clinical standpoint, but the results obtained by different experimenters on the lower animals concerning the same questions are at variance.

Experimental Studies.—Troje and Tangl,[16] to test the anti-bacillary action of iodoform, devised the following series of experiments: Iodoform vapor and powder were allowed to act on pure cultures, the powder was dusted on the culture medium in the neighborhood of cultures, and the vapor was allowed to accumulate in the culture chamber; animals were then inoculated with the growth and a series of "controls" was made. The vapor killed the bacilli only after fifty days, but then suppuration was produced by the action of chemical products as pointed out by Koch. After the vapor had acted six days, however, the rapidity of the growth of the bacillus was diminished, whilst it had quite ceased at the end of four weeks, and the bacilli at this stage were distinctly weakened. When strewed on the culture the drug so diminished the virulence of the bacillus that after sixteen days nothing but cold abscesses were formed after inoculation, many giant cells being present, and the course of the disease was very chronic. When mixed in the proportion of one part of the active culture to fifteen parts of iodoform, it was found that the bacilli were not always killed in fourteen days, although in one case they were quite innocuous at the end of eight days; at the end of three weeks they were dead, or at any rate harmless. The authors found also that they could obtain bacilli which would set up only chronic tubercle by means of the action of the iodoform outside the body, for when inoculating tubercle bacilli so treated they obtained a disease which was identical with *Perlsucht*, both in its clinical and pathological characters. Mixed with olive oil or glycerine in proportions of one part of iodoform to ten of the vehicle, they found that the organism was killed in sixteen days, the oil and the iodoform being much more efficacious than the glycerine mixture. Virulent bacilli can grow in the the tissues whatever iodoform mixture be intro-

[16]Berl. klin. Wochenschrift, No. 20, 1891. Supplement to British Med. Journal. July 18, 1891.

duced along with them, this being due to the fact that the tissues are such a good medium for the growth of the organism that the energy of the latter becomes very great, and the iodoform can exert little action on its growth, although outside the body where the conditions for growth are not so favorable the iodoform has a decided inhibitory effect. In the case of cold abscesses the growth of the bacillus is not so active, and therefore the iodoform has a better chance of exerting its valuable therapeutic properties. The authors found that the iodoform must act directly on the bacilli, as they have been able to demonstrate that it has a deleterious irritant action on the tissues; they also find that the action is most satisfactory in those cases where the number of bacilli is comparatively small, in which case the iodoform appears to prevent the growth of the bacilli. Their investigations have led them to the practical conclusion that iodoform is a true disinfecting agent as far as the tubercle bacillus is concerned; that it has a direct destructive effect upon the bacillus if left sufficiently long in contact. They have also shown that this drug diminishes the virulence of the tubercle bacillus and that cultures thus treated produce a more benign form of tuberculosis in animals.

Gosselin[11] made a series of experiments on animals with mercurial preparations and iodoform in order to ascertain if any of these substances could so alter the tissues as to render them unfit as a soil for the tubercle bacillus. He reasoned that if such a condition could be brought about by the introduction of chemical substances otherwise harmless an existing tubercular focus would be harmless, as local and general dissemination could no longer occur. Experiments with mercuric bichloride and biniodide had no effect in this direction. On the other hand these mercurial salts appeared to aggravate the tubercular process. Iodoform yielded better results. It was administered like the salts of mercury subcutaneously. It was his intention to render the animals refractory to the tubercle bacillus by saturating the tissues with iodoform prior

[11]Sur l'Attenuation du virus de la tuberculose, Études sur la tuberculose, 1er Juillet, 1887.

to the inoculation. He used a solution of iodoform of 10:100. Six rabbits were selected, three of which were subjected to iodoform treatment, while the remaining three were not thus treated, but kept under exactly similar conditions. Three drops of the ethereal solution of iodoform were injected under the skin every day for two months. In the beginning the iodoform was badly borne, as it diminished the appetite and caused frequent attacks of diarrhœa and the animals cowered in a corner of the cage and showed no inclination to move about. These symptoms always disappeared with the suspension of the injections. After a few days all the secretions and the tissues in different parts of the body responded to the iodine test.

The injections had to be made with great care as they were often followed by acute inflammation of the skin and subcutaneous cellular tissue. Four months later all of the animals were inoculated. The three control animals died of tuberculosis in from thirty to fifty days, the iodoformized animals showed a partial immunity and manifested no symptoms of tuberculosis until the expiration of fifty days, and death did not occur until from the seventieth to the ninetieth day after inoculation.

The same experiments were repeated three times with identical results. In two instances the iodoformized animals were killed respectively on the twenty-fifth and thirtieth day after operation.

Nothing further was found at the point of inoculation than a slight circumscribed peritonitis in one, and a limited area of adhesion between the peritoneal surfaces in the other. Examination of specimens stained by Ehrlich's method showed numerous bacilli in the adherent parts, and a fragment of lymph deposited on the surface implanted into the peritoneal cavity of a guinea-pig caused death from tuberculosis in twenty-seven days. Iodoformized guinea-pigs proved more refractory to the tubercle bacillus than rabbits; in one instance the animal lived one hundred and two days after inoculation.

In another very interesting series of experiments Gosselin reversed the experiments, rendering the animals first tubercular

rect antitubercular properties as expressed by Gosselin, but he is willing to admit that it has a potent influence in retarding the tubercular process. In opposition to the conclusions drawn by Gosselin he reminds his readers that it is well known that tuberculosis, under favorable circumstances, is occasionally spontaneously cured or curable. In 131 autopsies made at the Morgue Vibert he noticed evidences of a former tubercular process, which had become arrested spontaneously, and the patients succumbed to other diseases. In seventeen, out of the twenty-five cases, the former tubercular depôt was indicated by a cicatrix or chalky deposit. As further proof that tuberculosis does not always manifest progressive tendencies and undergoes a cure unaided by medication may be mentioned the writings of Leroux, Cruveilheir,[19] Rogeé, who in his work[20] makes the statement that in fifty out of one hundred autopsies, which he made on old men, he found evidences of pulmonary phthisis, which had been completely cured. Boudet;[21] Gaucherstudied carefully the process of spontaneous cure of tubercle by cicatrization. Similar and other observations in the same direction were made by Grisolle, Guencon de Mussy, Lebert, Jaccoud, Herard, Cornil, Peter and lastly the work of Thavu[22].

Jeannel[24] has made experimental investigation in the same direction concerning the curability of tuberculosis as Gosselin.

He made the following four series of experiments:

1. Local treatment alone.
2. Local and general treatment combined.
3. General treatment alone from the beginning of the disease.
4. General treatment alone from a period remote from the

[19]De la Tuberculose Chirurgicale, etc., Paris, 1890, p. 485.

[19]Anat. Path. Gén., T. 10, p. 616.

[20]Arch. Path. Gén. de Med., 1829, T. v.

[21]Thèse de Paris, 1843.

[22]Archives de Physiologie, 1878.

[23]Clinique Chir. des Mal. Chron., 1877.

[24]Recherches sur la Généralisation de la Tuberculose Expérimentale, Congrès de la Tuberculose, Paris, p. 351. Nouvelles recherches expérimentales sur la tuberculose et sa curabilité, Études sur la tuberculose, fasc., ii, p. 416.

beginning of the disease, that is, from the time inoculation was made.

On the whole, the results were not very encouraging. The local treatment alone or combined with general treatment did not prevent the development of tuberculosis, all of the inoculated rabbits died from well-marked tubercular affections and the treatment did not even retard the progress of the disease or postpone the fatal termination. General treatment alone inaugurated at the time the inoculation was made proved also inefficacious and Jeannel even intimates that the treatment by iodoform ether has neither the power to cure or to retard tuberculosis in the rabbit. Finally, general treatment alone instituted at a period remote from the beginning of the disease was a complete failure in every respect. Remarking how these results were so widely at variance with those claimed by Gosselin, the latter replied that he positively maintained the assertion previously made concerning the curability of local tuberculosis by treatment with iodoform injections. He at the same time insisted that generalization of tuberculosis varies with the place where the inoculation is made.

The discrepancy of the view entertained by these French investigators leaves the experimental field concerning the curability of tuberculosis by the local and subcutaneous use of iodoform open for future research to determine definitely the value of this remedy in the treatment of this disease.

Clinical Results.—The clinical results have been more uniformly in support of the anti-tubercular action of iodoform than the conclusions drawn from experimental work. The iodoform treatment of tubercular affections of bones and joints found an enthusiastic advocate in France in the person of Verneuil;[25] through his example and influence it found ready adoption at once in different parts of that country by the most prominent surgeons.

Vercherè[26] expresses himself as highly pleased with the results obtained by injections of ethereal solutions of iodoform,

[25]Injections d'ether-iodoforme dans les abcès froids. Revue de Chirurgie, 1885, p. 428, et sequi.

[26]Revue de Chirurgie, 1886, p. 476-502.

caused by ether vapor embolism, but Barvis attributes the death in this case to acute iodoform intoxication. In view of the fact that ether iodoform injections are always productive of pain, and not infrequently produce intense local reaction, and that the ether used may become a source of danger and that they are more liable to give rise to intoxication than when iodoform glycerine emulsion is used, the latter preparation should be used exclusively. In Germany the latter method of administration is used almost exclusively.

Bruns uses a 10% mixture of iodoform in glycerine or olive oil, always taking the precaution to sterilize the mixture. Krause recommends the following mixture:

℞	Iodoform subt. pulveris, - - -	50.0.
	Mucil. gummi Arab, - - - -	2.30.
	Glycerini, - - - - - -	83.0.
	Aq. distillat., q.s. ad., - - -	500.0.

S.: Ten per cent. iodoform mixture. To this mixture he adds one per cent of pure carbolic acid.

Whatever formula for the solution is selected, not more than half a drachm of the iodoform should be injected at the first time, and in children even less. If this dose does not produce any unpleasant symptoms, it may be increased the next time the operation is repeated. If used in this manner the risk of iodoform intoxication appears to be *nil* or at least very remote as not a single instance was observed in 108 cases treated in the Tübingen clinic by Bruns. The best results with iodoform injections come from the Halle and Tübingen clinics. This is undoubtedly owing to the fact that in these institutions this treatment has been very extensively used, and the large experience thus gained has enabled the surgeons to make a proper selection of cases, and apply the treatment in the most efficient manner.

Bruns[33] injects every two weeks a mixture composed of 10 parts of iodoform, 50 of glycerine and 50 of distilled water.

[33]Ueber die anti-tuberculöse Wirkung des Iodoforms, Verh. der. Deutschen Gesellschaft, f. Chirurgie, 1877.

sult could have been obtained by incision and curetting, but the latter treatment would have required more time and would have left unsightly scars. In favor of the iodoform treatment he also maintains that it is less likely to be followed by a relapse, and cites Trélat, Guyon, Bouilly, Nélaton, Richelot, Quenu, Peyrot and Bruns as entertaining the same opinion.

Tilanus[30] studied the antiseptic and antibacillary properties of iodoform, and concludes that it is a useful remedy in the treatment of tuberculosis.

Villemin[31] is of the opinion that iodoform is deserving of the confidence of the surgeons. The French surgeons have employed almost exclusively the ethereal solutions of iodoform (5.100) and we hear of cases in which,like in some of the experiments on animals, the injections caused a violent local inflammation and even gangrene. The injection is also painful, as the temperature of the body is sufficiently high to vaporize the ether in a very short time after its injection, which causes painful and sometimes dangerous tension in the joint or abscess. It appears also that iodoform intoxication occurs more frequently when the ethereal solution is used than when the iodoform is injected in the form of an emulsion in glycerine, or in olive oil. A case of death from iodoform intoxication was alluded to above and another occurred in the practice of Barvis.[32]

The patient was a soldier, æt. 24, the subject of a large cold abscess in the region of the left wall of the chest. This was punctured and after evacuation of its contents from 50 to 60 grammes of a 5% ethereal solution of iodoform were injected. Immediately after the injection the patient went into collapse, and it is possible that some of the solution was injected into the pleural cavity. In explanation of the sudden death it may be suspected that a small quantity of the ether vapor was forced into the venous circulation and that the collapse was

[30]Propriétes de l'iodoforme. Revue de Chirurgie février, 1890.

[31]Étude experimentale de l' action de guelques agents chimiques sur le development du bacille de la tuberculose, 1888.

[32]Du traitement des Abscèss froids, Intoxication iodoformique mortelle. Arch. de Méd. et de Pharmacie, T. xvi, No. 8, 1890.

In his first report he states that of 54 cases of tubercular abscess, 40 have recovered under this treatment.

In a later publication the same author[31] asserts that the anti-tubercular action of iodoform has been demonstrated. In order, however, for this drug to exert its specific action it is necessary that the whole interior surface of a joint or tubercular abscess should be acted upon and the action should be uninterrupted and continued for a long time. The curative effect often only becomes apparent after three or four months, but from this time the abscess gradually disappears. Of 100 cases of tubercular abscess treated in his clinic during the last five years 80% were cured, and during four years 50 cases of joint tuberculosis were also cured. He uses now a 10 to 20% mixture of iodoform in pure glycerine or olive oil prepared fresh and thoroughly sterilized before each injection.

In the case of fungous joints he makes the injection not only into the cavity of the joint, but also into the thickened capsule, making the puncture at different points and injecting from 2 to 6 cm. of the mixture. In tubercular hydrops and tubercular abscess the fluid or softened contents are first removed, whereupon 10 to 30 cm. of the mixture are injected.

Neither pain nor symptoms of local irritation follow the procedure, but the temperature usually shows a rise from one to two degrees, which, however, disappears after a few days. He does not immobilize the injected joints. He has never met with cases of iodoform intoxication from the injections. Parenchymatous injections are to be repeated every eight days, intra-articular injections every two to four weeks. Symptoms of improvement seldom appear before the expiration of six to eight weeks, although the pain diminished at an earlier date.

Shrinking of the fungous capsule is the surest indication of beginning improvement. In children suffering from tuberculosis of joints the functional result is frequently perfect if the treatment is begun before the disease has resulted in extensive destruction of the soft structures of the joint. In adults the

[31] Ueber de Behandlung tuberculöser Abscesse und Gelenkerkrankungen mit Iodoform injectionen. Beiträge zur klinischen Chirurgie, vi, 3, p. 639, 1890.

best results often consist in a useful but partially or completely anchylosed limb.

Wendelstadt[35] uses a mixture of iodoform in olive oil in the proportion of 5:25. He insists that the mixture should be prepared fresh every time, as in mixtures kept for some time free iodine is generated, the presence of which can be recognized by the mixture presenting a brownish red color.

As a parenchymatous injection he throws from 2 to 3 cm. of this mixture into the tissues with an ordinary Pravaz syringe. The injection is repeated every eight days; the puncture should always be made at a different point in order to reach successively different parts of the focus.

In several cases he observed a rise in the temperature to 40° C. the same day, but the febrile reaction always subsided in a short time. This method was applied in 109 cases of local tuberculosis; of this number 28 were later treated by incisions and évidement. A permanent cure was obtained in 36, improved 37, and not much benefited 12, and 24 remained under treatment.

Andrassy[36] gives the particulars of the 22 cases of cold abscesses treated by iodoform injection that were first reported from the Tübingen clinic by Bruns. Of this number 20 were perfectly and permanently cured. In one case the abscess had to be opened. The largest dose of iodoform used was 10 grms. No symptoms of intoxication were observed in any of these cases, but occasionally a considerable rise in temperature followed the procedure. In most cases the operation had to be repeated two or three times at intervals of two weeks. The healing process was generally completed in from one-half to two and one-half months.

Billroth[37] uses a 10% iodoform glycerine emulsion. The tubercular joint or abscess is evacuated and from 40 to 50

[35]Zur Behandlung der tuberculösen Knochen und Gelenkerkrankungen durch parenchymatöse Injectionen von Iodoformol. Centralblatt f. Chirurgie, No. 38, 1889.

[36]Beiträge zur Behandlung der kalten Abscesse, insbesondere mittelst Iodoforminjectionen. Bruns' Beiträge zur klinischen Chirurgie, ii, 1887.

[37]Ueber die Behandlung kalter Abscesse in tuberculoser Caries mit Iodoform Emulsion.

grammes of the mixture are injected. The injection is not repeated until the urine no longer reacts to the iodine test.

During two years Krause[38] treated tubercular affections of the following joints by intra-articular injections of iodoform:

Knee-joint,	36.
Hip-joint,	13.
Tarsal-joint,	6.
Wrist-joint,	5.
Elbow-joint,	1.

The treatment was not completed in all of these cases, but a cure had been effected in the following:

Knee-joint,	15.
Hip-joint,	4.
Tarsal-joint,	1.
Wrist-joint,	3.

Three of the cases that were cured were sent to the clinic to undergo an amputation.

Although in the cases where the wrist-joint was involved the treatment failed in restoring motion, it made the fingers more movable and useful. In the hip-joint cases recovery usually resulted in almost total anchylosis.

This was evidently due to the fact that the severest cases were subjected to this treatment, and much better functional results can be expected if this treatment is commenced during the early stages of the disease.

Improvement was noted in nearly all cases that remained under treatment. The best results were realized from the treatment in tuberculosis of the knee and wrist-joints. He recommends that if the canula of a large trocar is not large enough through which the joint can be completely emptied of its contents that an incision should be made for this purpose, and the wound sutured before the injection is made.

Of the cold abscesses which were subjected to treatment by

[38]Ueber den heutigen Standpunkt in der Behandlung der tuberculosen Knochen und Gelenk Krankheiten. Berl. klin. Wochenschrift, No. 49, 1890.

iodoform injection 50% were cured. He believes that intoxication symptoms are not produced by using emulsion of iodoform because none of the iodoform is in solution and on this account absorption is very slow. He has injected the emulsion which he uses in doses varying from 5 to 80 grammes. The injections never caused much pain but were often followed by a rise of temperature for a short time. The first symptoms which denote that improvement is taking place are lessening of pain and diminution of swelling. Peri-articular abscesses recurred several times after they were apparently cured and required repetition of treatment.

Trendelenburg has treated 135 cases of all grades of severity by the injection method, making one injection of five grammes every eight days. The most striking results were obtained in wrist-joint tuberculosis in adults—a disease which usually gives a bad prognosis and frequently necessitates amputation. In 68% of all cases the treatment had a favorable effect.

Immediate and Remote Dangers Attending Iodoform Injections. The dangers attending the treatment of tubercular affections of bones and joints by iodoform injections may arise from iodoform intoxication, the action of the menstruum employed, secondary infection, and injury of important parts by the instrument used in making the puncture.

In a case of Boeckel's,[39] the patient died during the operation. It was found that the abscess communicated with the subclavian artery. In three of König's[40] cases the puncture of the abscess was followed by profuse hæmorrhage, due to arterial erosion. The arteries involved were the gluteal, the deep femoral, and the external plantar. These had to be ligated. A similar complication occurred in two cases under the care of Lindner,[41] one of fatal hæmorrhage from the femoral, and the other from the iliac vein.

Dollinger[42] does not approve of the iodoform ether injec-

[39]London Medical Record, 1889.

[40]Centralblatt f. die gesammte Therapie, 1887.

[41]Deut. Med. Woch., 1887.

[42]Beiträge zur Iodoform-ether behandlung der tuberculosen Knochen entzündung. Centralblatt f. Chirurgie, May 18, 1889.

tions as advised by Verneuil, as he has found in his experience that in children they did not induce recovery in a single case. He not only regards them useless, but harmful, as the injection of even small doses produced deafness, headache, and nausea, while larger quantities were followed by loss of consciousness, impaired respiration and acute cystitis. At the moment of injection some headache may be felt, and there may be an evening rise of temperature of 3 to 4 degrees. The rapid evaporation of the ether may cause necrosis of the abscess wall, and if, for example, psoas abscess from rapid over-distension should rupture into the peritoneal cavity, death might result from such injections from septic peritonitis.

Heusner[43] reports a case of iodoform intoxication caused by an intra-articular injection of 0.1 of iodoform in glycerine. Bramann observed quite grave symptoms of intoxication after an injection containing 2.0 of iodoform. The patient was a boy. Later, the injection of the same amount produced no untoward symptoms.

Trendelenburg first used iodoform ether, but in a short time the injection produced gangrene of the overlying abscess wall in three cases, and after that he has used the emulsion exclusively and has not observed such a result since. Gangrene of the overlying tissues and iodoform intoxication have only been observed after iodoform ether injections; the first is caused by the overdistension resulting from vaporization of the ether and the latter is due to rapid absorption of the iodoform kept in solution by the ether. Another possible remote source of danger attending the injection of the ethereal solution is the entrance of ether vapor into one of the veins causing death from ether-embolism.

The dangers just enumerated do not belong to injections of iodoform held in suspension in glycerine or olive oil. Accidental infection, which has occasionally occurred during or after the injection, is, of course, caused by a faulty antisepsis, and has happened from the use of iodoform by parenchymatous and intra-articular injections irrespective of the menstruum used. If such an accident takes place, it will become neces-

[43]Berl. klin. Woch., Oct. 5, 1891.

sary to make a puncture with a large trocar and evacuate the pus through the canula and resort at once to irrigation, with a 3% solution of boracic acid, or treatment by incision and drainage may be required. Dangerous hæmorrhage is occasionally encountered in treating tubercular abscesses by incision and scraping when a vessel of considerable size has become eroded and the possible occurrence of this accident does not militate against the treatment by iodoform injections.

Action of Iodoform on Tubercular Tissue.—If iodoform in the form of an emulsion is injected into an empty tubercular joint or abscess, and an effort made to diffuse it over the whole interior surface, by passive motion, pressure and rubbing, the fine particles of iodoform will soon be equally distributed over the entire surface clinging to the granulations, fibrinous masses, or the cheesy material lining the cavity. The iodoform produces no violent irritation, its action on the tissues is mildly stimulating. The re-accumulation of fluid in the joint or tubercular pus in the abscess is slow and if the procedure is repeated after eight days to two weeks the fluid withdrawn will contain particles of iodoform, showing that the absorption of this substance, when not applied in solution, is very slow. At the same time the fluid will have changed its character somewhat, containing elements the presence of which indicates that remnants of dead tissue products of coagulation necrosis are being thrown off and that a reparative process has been initiated. The first effect of the iodoform on the tissues lining the joint or cavity is to bring about rapid disintegration of the tubercular product, which then is displaced by a layer of active and very vascular granulations.

Bruns and Nauwerk[1] incised tubercular abscesses treated by iodoform injections at different intervals after the injection and extirpated pieces of the abscess wall for microscopical examination. A few weeks after injection they found that the tubercle bacilli had disappeared, the miliary tubercles softened by infiltration with round cells and œdematous inhibition of a serous fluid; further on the tubercles disappeared by fatty de-

[1] "Ueber die antituberculose Wirkung des Iodoforms, Klinische und Histologische Untersuchungen. Beiträge zur Klinischen Chirurgie, iii. Tübingen, 1887.

generation of the cells and liquefaction of the cellular detritus. Hand in hand with the degeneration and liquefaction of the tubercular product could be witnessed in the adjacent tissues a process of repair in the shape of a wall of granulation tissue which formed a line of demarcation between the healthy and diseased tissue which consumed in part the dead sterile tubercular tissue and detached the balance. As soon as the dead tissue was disposed of by absorption the granulations began to cicatrize and were gradually converted into connective tissue, and with this change the process of the healing was completed. Krause made similar examinations and corroborates the observations made by Bruns and Nauwerk. That the curative effect of iodoform in the treatment of tubercular joints and abscesses is not owing to the mere puncture and evacuation, but is brought about by the specific action of iodoform on the tubercular products there can be no doubt as tapping for these conditions was employed long before iodoform was used in surgery, but this procedure seldom yielded more than temporary relief. Stockma treated five tubercular abscesses by tapping alone but always with negative results. If he injected the contents of tubercular abscesses, treated by different methods, into the anterior chamber of the eye in rabbits, the result was always positive, except in the case of abscesses treated by iodoform injections, in which a sufficient time had elapsed for the iodoform to exert its specific anti-bacillary effect. Iodoform exercises a double therapeutic action on tubercular tissue when used by parenchymatous or intra-articular injections, it destroys the bacillus of tuberculosis and aids the removal of the dead sterile tissue and favors the subsequent reparative process by its stimulating action on the surrounding healthy tissue, properties not possessed to the same degree by any other, as yet known, substance.

Indications.—The curative power of iodoform injections has so far been most manifest in the treatment of heretofore most hopeless cases of surgical tuberculosis, tubercular abscess in connection with an inaccessible osseous focus. One of the most brilliant achievements of modern surgery is the successful treatment of tubercular abscesses developing in the course of tubercular spondylitis by iodoform injections. Statistics

show that more than 50% of such cases are amenable to this method of treatment. In the successful cases not only the abscess but the primary bone lesion is also cured.

One of the most striking illustrations of the efficiency of iodoform treatment in these grave cases recently came under my observation. The patient was a delicate girl, æt. 8, who had suffered from a tubercular spondylitis at the junction of the last dorsal with the first lumbar vertebra for six months. Slight angular posterior curvature. Within two months an enormous abscess developed in the right lumbar and iliac regions. Below the abscess extended as far as Poupart's ligament, above to the last rib. The abscess was very prominent in the lumbar and inguinal regions. The child had a temperature of 104° F. every evening. The abscess was punctured under strict antiseptic precautions in the lumbar region, and nearly two quarts of tubercular pus evacuated. The abscess cavity was irrigated with a 3% boracic acid solution until the fluid returned perfectly clear and two ounces of a 10% mixture of iodoform in glycerine injected. The puncture was sealed with a pledget of antiseptic cotton and iodoform collodium.

The first injection had no effect in reducing the temperature. At the end of a week it was repeated, and about half as much tubercular pus removed. The temperature in a few days after the second injection was normal. The third and last injection was made four weeks after the first. At this time only about 6 ounces of a viscid fluid were removed. The child improved in general health, and after this time no reaccumulation of fluid occurred. At the present time, six months after treatment was commenced, the child is wearing a plaster-of-Paris corset, and appears to be in perfect health.

No one who is familiar with the efficacy of iodoform injections in the treatment of tubercular abscesses would or should neglect to resort to it when called upon to treat tubercular abscess in communication with an inaccessible primary tubercular focus. This applies with special force to abscesses developing in connection with tuberculosis of the vertebræ and some of the pelvic bones.

This treatment is again applicable and has yielded excellent

results in tuberculosis of the knee and other readily accessible joints with or without the formation of para-articular abscesses.

The treatment is most useful if the joint is distended with fluid, as under such circumstances, after the removal of the fluid the iodoform can be brought in contact with the entire surface of the cavity. This is often impossible if portions of the joint have been shut out by intra-articular adhesions. Irrigation of the joint should never be omitted if it contains pus, flakes of lymph, or detached broken down fragments of tubercular tissue, and it is in such cases that the canula of even a large trocar is often not of sufficient size to evacuate the joint or abscess properly, and that the puncture has to be followed by an incision large enough to meet the requirements.

If the joint contains no fluid it is difficult and usually impossible to reach all of the infected tissues by an intra-articular injection, and it is in such cases that it must be combined with parenchymatous injections, and the site of puncture changed at each operation. As no fluid is to be removed, and no irrigation to be made under such circumstances, the necessary amount of iodoform emulsion is thrown into the joint and into the thickened fungous capsule with an ordinary Pravaz syringe, supplied with a large needle. The puncture is made at different points every time the procedure is repeated. It cannot be expected that a cure can be effected by this method of treatment if the primary focus contains large masses of cheesy material, or a sequestrum of considerable size. But even in such cases, if the injections are made with the requisite degree of care, the treatment is harmless and results in great benefit in preparing the parts for subsequent surgical treatment by operation.

Points to Be Remembered in Making Intra-Articular and Parenchymatous Injections.—The strictest antiseptic precautions must be practiced in making the injections, as neglect in this direction would not only interfere with an ideal result of the treatment, but would expose the part and the patient to the risks and dangers incident to a suppurative inflammation with all its immediate and remote consequences. The surface where the puncture is to be made should be shaved and thoroughly scrubbed with hot water and potash soap, and careful-

ly disinfected by washing with an antiseptic solution, and lastly with pure alcohol. The trocar should be sterilized by boiling, or passing it slowly through the flame of an alcohol lamp. The emulsion must be prepared fresh, and sterilized. If a syringe is used for making the injection it should be one with an asbestos disc for the piston and kept in an aseptic condition. If a rubber bulb and rubber tubing is employed, these must be sterilized. The point where the puncture should be made in operating on the different large joints has already been described. The cardinal rule in all operations should be to select the shortest route from the surface into the different joints, and at a point where no important structures will come into the line of the proposed puncture. In injecting a tubercular abscess the puncture should not be made where the abscess wall is thinnest, but some distance from the most prominent point of the swelling, so that the puncture will be made through healthy skin, and not through tissues reduced in vitality from the long continued pressure from beneath. Before the puncture is made, the skin is drawn to one side, so that after the removal of the canula the puncture in the deep tissues may be subcutaneous.

The ethereal solution of iodoform should never be employed, as its use is attended by greater immediate and remote risks than if the iodoform is used in suspension in a non-volatile menstruum.

The best method of using the iodoform is a 10% mixture in glycerine or olive oil. The quantity of the mixture to be injected must vary somewhat according to the age of the patient and the size of the tubercular focus. From three drachms to an ounce is the average dose. In injecting a tubercular joint which contains fluid or a tubercular abscess, irrigation with a 3% solution of boracic acid should be employed until the fluid returns perfectly clear before the iodoform injection is made. If the joint or abscess cavity contains broken down tubercular products which can not be removed through a large canula, the joint or abscess should be freely incised, the interior scraped and rubbed out with iodoform gauze, wound sutured and then the injection made, a plan of treatment practiced with great success by Billroth.

In making parenchymatous injections the needle should be inserted in different directions without removing it completely, and the injection made at as many points as possible in order to saturate as large a territory as possible of the infected tissues. If the procedure is to be repeated the puncture is made some distance from the first so as to medicate a new area of tubercular tissue.

After the canula is withdrawn the puncture in the skin should be carefully sealed with a pledget of aseptic cotton and iodoform collodium. Mechanical diffusion of the injected material should be secured after the injection by kneading, compressing and rubbing the parts, and by making passive motion. The injection is not to be repeated oftener than every eight days to two weeks, and the treatment continued until the tubercular material has been removed and healing by cicatrization is in progress.

In the treatment of tubercular joints by iodoform injections, immobilization is only necessary if active motion of the joint is productive of great pain. In tubercular spondylitis with abscess, the iodoform treatment should be combined with the necessary orthopœdic treatment. In tuberculosis of bones and joints, with a large caseous mass or a sequestration of considerable size at the primary focus the iodoform treatment can not take the place of mechanical removal of the infected and dead tissue, but is often of great value as a preliminary measure to prepare the way for a radical operation.

Cases of Tuberculosis of Bones and Joints Recently Treated by Iodoform Injections in the Surgical Clinic of Rush Medical College.—The most brilliant result of treatment by iodoform injections that came under my own personal observation was the case of tubercular spondylitis reported above. The local and general improvement was manifest after the second injection, and complete cure, not only of the enormous abscess, but also of the primary bone lesion, was realized in less than three months.

The cases reported below were treated in the clinic of Rush Medical College since April, 1891. In some of the cases the ultimate result of the treatment could not be ascertained, as the patients failed to report. A 10% emulsion of iodoform

in glycerine was the preparation used exclusively. The intra-articular injections were made with a two ounce glass syringe, which was connected with the canula, after withdrawal of fluid, or, in case the joint was irrigated with a solution of boracic acid after completion of this procedure, by a piece of aseptic rubber tubing which was tied firmly over the distal end of the canula and the nozzle of the syringe. Special care was exercised to prevent the entrance of air into the joint. As a rule, the patients were permitted to use the limb moderately during the entire treatment. An exception to this rule was made in the cases of tuberculosis of the hip joint and in affections of the knee-joint when the joint was much contracted.

In no case was the injection followed by suppuration, intoxication or any other immediate or remote untoward symptoms. As a rule, the pain following the injection was slight and of short duration. The injection was always followed by some swelling, which reached its maximum about the second day. Improvement of the joint lesion was always announced by a change in the character of the effusion in the cases in which this condition of the joint existed. If the joint or abscess contained tubercular pus, the first change noticed was gradual disappearance of the solid portion of the fluid, such as shreds of lymph and fragments of tubercular tissue, at the same time the fluid became more viscid, bearing a strong resemblance to thin mucus. As soon as this stage was reached the effusion disappeared speedily and permanently with contemporaneous improvement of all the remaining symptoms.

CASE I. Laboring man, æt. 27; has inherited a rheumatic tendency; presented himself for the first time in the clinic April 23, 1891; general health unimpaired; no signs or symptoms of pulmonary tuberculosis. Nine months ago he experienced pain on the inner side of the right knee joint. This pain was not constant, but was always aggravated by active exercise. Five months later the joint became swollen. When first examined, the joint was uniformly swollen, movements of limb unimpaired; upper recess of synovial sac quite prominent, fluctuation distinct; no tender points over condyles of femur or head of tibia. Primary synovial tuberculosis with hydrops was the diagnosis made at the time.

The joint was punctured with a medium sized trocar and about four ounces of a turbid synovial fluid, in which small flakes of lymph were suspended, were removed. The tapping was followed by irrigation of the joint with a 3% solution of boracic acid until the fluid injected returned perfectly clear. One ounce of iodoform emulsion was injected. The patient was advised to use the limb moderately. During five weeks the same procedure was repeated three times, and at each successive tapping the fluid removed was less in quantity and more viscid. When the patient was seen again after the fourth injection the joint presented a normal appearance, no effusion, and thickening of capsule nearly disappeared; motion of joint nearly normal. As the patient has not reported since that time it is fair to assume that he has completely recovered.

CASE II. Boy, æt. 8, with good family history, entered the Presbyterian Hospital Oct. 25, 1890, suffering with hip disease. The disease commenced soon after an injury which he received in April, 1889. Rest in bed and extension by weight and pulley was the treatment employed. Under this treatment the pain subsided, but the swelling and tenderness remained stationary. During the month of May three injections, from two drachms to half an ounce of the emulsion each time, were made into the joint. As it was almost certain that the head and neck of the femur were the primary seat of the inflammation in this case, I made it a point to penetrate the neck of the femur deeply with the small trocar in order to attack existing osseous foci by the same treatment. The emulsion was first thrown into the substance of the bone, and later, after withdrawing the canula as far as the surface of the bone, into the joint.

Several days after the last injection the pain became suddenly aggravated and the limb shortened in spite that extension was kept up uninterruptedly, at the same time the limb was rotated inward. It was now decided to resect the joint. The operation was performed June 7. The great trochanter with the muscles attached to it was cut away from the shaft at the base of the neck of the femur with a chisel, and after the resection of the joint was replaced and fastened to the shaft with two catgut sutures. Inspection of the joint now explained the symptoms which had developed recently so suddenly.

The head of the femur, partially destroyed, had slipped out of the acetabulum and was resting upon its upper brim. A number of foci were found in the neck of the femur in close proximity to the head, the joint was filled with granulations. No signs of caseation. The granulations were firm and of a bright red color, and I have no doubt

had this accident not occurred the parenchymatous and intra-articular injections would have resulted finally in a cure. The neck of the femur was divided at its junction with the shaft with a broad chisel and removed with the head. The capsule was extirpated, and the granulations lining the acetabulum scooped out with a sharp spoon. Extension in abducted position was continued for several weeks. Primary healing of the wound and only very slight shortening, with leg in excellent position.

CASE III.—Farmer, æt. 53, with a family history of tuberculosis, came to the clinic to be treated for tuberculosis of the wrist joint of three years' standing. General health fair; muscles of arm atrophied; hand slightly flexed; arm in position half way between pronation and supination. Swelling extended over the entire wrist joint, and presented all the characteristic clinical features of tuberculosis of this joint. During the course of five weeks he received three iodoform injections, the quantity of emulsion used each time being sufficient to distend the joint fully. After the second injection the swelling and pain began to subside, and four weeks later the joint was practically cured. The injections were always made below the styloid process of the ulna or radius, from which point the trocar was made to traverse the entire joint from side to side; the injection was made slowly and at different points, as the canula was withdrawn.

CASE IV. Girl, æt. 4, with good family history, was brought to the clinic June 25, suffering from typical tuberculosis of the right knee-joint. The disease commenced five weeks ago with pain and lameness. No evidences of tuberculosis in any other organ; general health fair; knee-joint slightly flexed, but only moderately swollen; no effusion in joint; capsule thickened, and upper recess of synovial sac evidently the seat of fungous granulations. Tenderness over the internal condyle of the femur suggested an osseous origin of the intra-articular inflammation. The knee-joint was punctured but no fluid escaped. In order to ascertain whether the whole knee-joint could be medicated by intra-articular injection, boracic acid solution was forced into it from a fountain syringe until the whole joint was fully distended; it held about two ounces. Half an ounce of iodoform emulsion was then injected. The joint became more swollen, painful and tender after the first injection. The same quantity was injected July 11, August 4, and September 1.

At the present time the position of the limb is normal, motion of joint fair, thickening of capsule greatly diminished and tenderness over condyle less.

CASE V. Girl, æt. 7, was admitted into the Presbyterian Hospital, March 24, 1891, with well-marked advanced tubercular disease of hip-joint, of two years' duration. The little patient is anæmic and emaciated. Treatment by extension and parenchymatous and intra-articular injections of iodoform. March 24, April 28 and May 28, half an ounce of iodoform emulsion was injected into the neck of the femur and hip-joint. At first the patient appeared to improve, but later her general condition became gradually worse, and an abscess formed. Resection of the hip-joint was made July 16. September 9 the wound was nearly healed, and the general condition much improved. The resected specimen contained a number of caseous foci which at least in part would explain the failure of the iodoform treatment.

CASE VI. Girl, æt. 7, child of healthy parents, has been suffering for two months from chronic inflammation of the knee-joint. Swelling has only recently appeared; limb is flexed at an angle of 140°; pain aggravated on motion of the joint; no fluctuation; tenderness over condyles of femur.

DIAGNOSIS.—Dry fungous synovitis with osseous foci in condyles of femur. Half an ounce of iodoform emulsion was injected into the joint and the thickened capsule at six different times from March 18 to July 28.

August 13, the joint was carefully examined, and the appearances were such as to warrant the assumption that the joint lesion was cured. Pain and tenderness on moving the joint, as well as in the condyles of the femur, had disappeared. The limb was now easily straightened, while the patient was under the influence of an anæsthetic, and immobilized in a plaster-of-Paris dressing.

September 11, splint removed; position of limb satisfactory; further treatment, consisting of massage, passive motion, directed. Patient can walk without the aid of mechanical support. Pain, tenderness and swelling have disappeared completely.

CASE VII. Laborer, æt. 19, good family history. Two years ago had an attack of peritonitis, which was followed by pain and swelling of one of the wrist joints. An abscess formed, and was opened four months after commencement of joint affection An operation was made a year ago. When patient was presented for the first time in the clinic, the wrist joint was very much swollen, and skin over it for some distance œdematous. Hand flexed and forearm pronated. Fistulous openings led to carious bone; lower end of radius and ulna enveloped; suppuration slight; general health materially impaired. Evidement of joint; wound packed with iodoform gauze, and forearm,

as far as base of fingers, supported by a well padded anterior splint. The sinuses were injected with iodoform emulsion twice a week for two months. At this time the wound was healed completely, and the patient has secured good use of hand, being able to perform manual labor.

CASE VIII. Laborer, æt. 20; family history good. For a number of weeks patient has experienced pain in left knee joint, which was followed by swelling four weeks ago, since which time he has not been able to follow his occupation. At the time treatment was commenced, August 11, the knee-joint was distended with fluid, patella raised at least half an inch from anterior surface of condyles, upper recess of joint very prominent, and conspicuous bulging on each side of patella. Diagnosis: Primary synovial tuberculosis with hydrops of joint. General health not much impaired. Joint was tapped, and ten ounces of turbid synovial fluid, mixed with shreds of lymph, removed. The joint was washed out repeatedly with a 2% solution of boracic acid, until the fluid returned perfectly clear, when, by compression, the joint was completely emptied and an ounce of iodoform emulsion was injected. Next day the joint was swollen as much as before the tapping. The patient returned August 25, and stated that the treatment had proved beneficial to him. The joint was again tapped, but only half the quantity of fluid removed as the first time. The fluid removed contained no shreds, and was clearer and more viscid than at the first tapping. The second injection produced less swelling and pain than the first. Two weeks later the swelling had completely disappeared, thickening of capsule less, and the patient has since recovered almost perfect use of limb.

CASE IX. Brakeman, æt. 22, was admitted into Presbyterian Hospital April 15, 1891; tuberculosis not hereditary in his family. About five years ago patient experienced a sudden pain in left knee, which was followed very soon by swelling and local heat. Since that time the knee has been injured on three different occasions, and each accident was always followed by aggravation of symptoms. About 18 months ago the pain diminished, but patient was unable to walk without the aid of crutches. The patient is anæmic and considerably emaciated; knee-joint swollen and flexed; no effusion in joint, but capsule thickened throughout; circumscribed point of tenderness over inner tuberosity of tibia. Careful search reveals absence of tuberculosis in other organs. Diagnosis: Tubercular osteo-arthritis with a probable focus in the inner tuberosity of tibia. Two iodoform injections were made two weeks apart, but as no improvement followed typical resec-

tion of knee-joint with preservation of patella was made May 3, 1891. The whole synovial membrane was found converted into a granulation mass, and capsule of joint much thickened. The base of two triangular sequestra in the head of the tibia projected into the joint. The articular surface of the two fragments of necrosed bone was much worn, and presented a polished surface. Primary union of wound and bony consolidation of resected ends in six weeks. The inefficacy of iodoform treatment was explained by the pathological conditions revealed at the operation. Secondary tubercular synovitis following extensive necrosis from occlusion of an artery by a tubercular thrombus or embolus is not amenable to this kind of treatment. If in such cases this treatment is not followed by improvement after the second or third injection, resection is indicated and the operation should not be postponed.

It is my opinion that even in such cases the preliminary treatment by iodoform injections is of great value, as it brings the intra-articular structures in better condition for successful operative treatment. I regard intra-articular and parenchymatous injections of iodoform as the best preparatory treatment for the resection of tubercular joints in which this treatment does not meet the pathological indications.

CASE X. Boy, æt. 17, with a tubercular family history, applied for treatment in the college clinic, June 18, 1891. When 2 years old, symptoms of tubercular spondylitis in the dorsal region first developed. In spite of the usual treatment made use of for this affection an extensive posterior curvature formed. The patient, although 17 years of age, is not taller than a boy of 7 or 8 years. About 6 months ago a swelling was detected in the left iliac region which rapidly increased in size. The patient is very anæmic, and greatly emaciated. The curve involves at least eight or nine of the upper dorsal vertebræ. A fluctuating swelling reaching from Poupart's ligament to the costal arch, and extending to near the median line, was found on the left side. Diagnosis: Tubercular spondylitis of upper dorsal vertebræ, which has resulted in the formation of an immense lumbar abscess, which in all probability still communicates with the primary osseous lesion. The abscess was tapped in the lumbar region immediately below the last rib and six pints of characteristic tubercular pus were evacuated. The abscess was washed out repeatedly with a solution of boracic acid until the fluid returned perfectly clear, after which an ounce of iodoform emulsion was injected.

Between June 18 and August 5, tapping, irrigation and injection was repeated four times. At each tapping the quantity of fluid re-

moved was less, so that the last time not more than four ounces of a viscid opaque fluid were removed. Since then there has been no reaccumulation of fluid, and the general condition of the patient has very much improved. In its result the treatment in this case has proved equally satisfactory, as in the case of tubercular spondylitis described above. These two cases have satisfied me that the iodoform treatment will prove most beneficial in the treatment of chronic abscesses which develop in the course of tubercular spondylitis. The value of this method of treatment in such cases cannot be over-estimated inasmuch as little can be expected from operative treatment in tuberculosis of the vertebræ.

Dr. Ochsner, assistant to the chair of surgery in Rush Medical College, has kindly consented to follow these cases in the future, and make later a supplementary report. It is only by keeping such cases under observation for months and years that reliable statistics as to the ultimate results of this as well as any other method of treatment for tubercular affection of bones and joints can be obtained. The immediate effect of the treatment has proven highly satisfactory in my hands, and in conclusion, I can only urge its more general adoption by American surgeons.

Conclusions.

1. Parenchymatous and intra-articular injections of safe anti-bacillary substances are indicated in all subcutaneous tubercular lesions of bones and joints accessible to this treatment.

2. Of all substances so far employed in this method of treatment iodoform has yielded the best results.

3. The curative effect of iodoform in the treatment of local tuberculosis is due to its anti-bacillary effect and its stimulating action on the healthy tissue adjacent to the tubercular product.

4. A 10% emulsion in glycerin or pure olive oil is the best form in which this remedy should be administered subcutaneously.

5. The ethereal solution should never be employed, as it is liable to cause necrosis of the tissues overlying the abscess and iodoform intoxication.

6. Tubercular abscesses and joints containing synovial

fluid or tubercular pus should always be washed out thoroughly with a 3 to 5% solution of boracic acid before the injection is made.

7. Injections should be made at intervals of one or two weeks, and their use persisted in until the indications point to the cessation of tubercular inflammation and the substitution for it of a satisfactory process of repair, or until the result of this treatment has shown its inefficacy and indications present themselves of the necessity of resorting to operative interference.

8. If the treatment promises to be successful, symptoms pointing to improvement manifest themselves not later than after the second or third injection.

9. In tubercular empyema of joints and tubercular abscesses gradual diminution of the contents of the joint or abscess at each successive tapping, lessening of the solid contents of the fluid and increase of its viscidity are the conditions which indicate unerringly that the injections are proving useful and that in all probability a cure will result from their further use.

10. Moderate use of limb is compatible with this method of treatment provided the disease has not resulted in deformities which would be aggravated by further use of the limb; in such cases correction of the deformity should be postponed until the primary joint affection has been cured by the injection.

11. Parenchymatous and intra-articular medication with anti-bacillary remedies has yielded the best results in tubercular spondylitis attended by abscess formation and tuberculosis of the knee and wrist-joints.

12. This treatment may prove successful in primary osseous tuberculosis followed by involvement of the joint, provided the osseous foci are small.

13. Extensive sequestration of articular ends with secondary tubercular synovitis always necessitates resection, but preliminary treatment by iodoform injections into the affected joints constitutes a valuable preparatory treatment to the operation and adds to the certainty of a favorable result.

14. In open tubercular affections of joints, incision, scraping, disinfection, iodoformization, iodoform gauze tampon, suturing, and subsequent injections of iodoform emulsion as advised by

Billroth yields excellent results, and should be employed in all cases in which a more formidable operation can be avoided.

15. Balsam of Peru ranks next to iodoform in the treatment of tubercular affections of bones and joints and if the latter remedy for any reason cannot be employed or has failed in effecting the desired result, it should be given a fair trial if operative treatment is not urgently indicated.